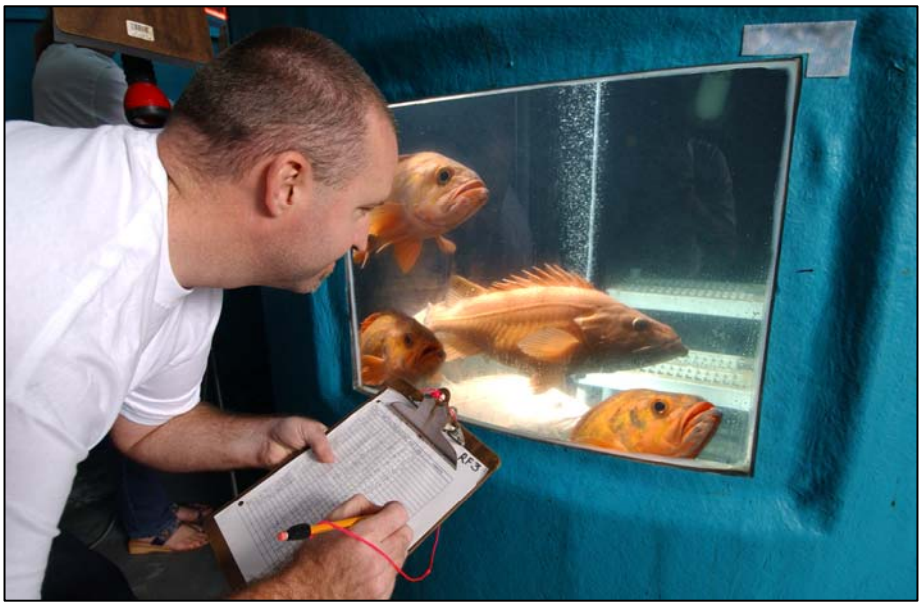
Aquaculture Quick Facts



Hubbs-SeaWorld Research Institute

Hubbs-SeaWorld Research Institute is dedicated to ensuring that future generations experience the benefits of a healthy environment by conserving the ecological integrity of our oceans and estuaries as a foundation for marine-based economies, sustainable fisheries, public recreation, transportation, tourism, and quality of life.

http://www.hswri.org/

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Aquaculture Today

- Aquaculture is a general term describing the cultivation of animals and plants in water, which could include oceans, rivers, lakes and other aquatic environments. Mariculture is ocean-based or marine aquaculture.
- Global production from aquaculture is increasing by about 11 percent per year - "The world's fastest growing food producing sector." - according to the Food and Agriculture Organization of the United Nations (FAO).
- Fish and shellfish produced from farming activities currently account for 37 Percent of all seafood directly consumed by humans (FAO, 2003).
- Fish produced by aquaculture are similar in quality to fish landed by capture fisheries. They are safe to eat and highly nutritious. They are sold in most grocery stores and presently include Atlantic salmon, tilapia, catfish and rainbow trout.
- Aquaculture techniques are used for fishery replenishment programs as well as production for direct human consumption. Examples include California's salmon hatcheries and HSWRI's white seabass restocking program.

Global Facts

- Fish is man's most important single source of high-quality protein, currently providing 16 Percent of the animal protein consumed globally, or roughly one fifth of all animal protein in the human diet.
- Today, fish is the only important food source that is still primarily gathered from the wild rather than farmed.
- Globally, there are 210 different farmed aquatic animal and plant species: 131 finfish species, 42 molluscan, 27 crustacean, 8 plant and 2 amphibian and reptile species (FAO).
- In the U.S., there are 19 reported commercially cultured species: 6 finfish species, 4 molluscan species, 2 crustacean and 7 other aquatic plant, amphibian and reptile species.
- During the period 1992 - 2001 total world fish and shellfish supply increased by 29.4 percent while supply from wild capture fisheries increased by only 8.3 percent. (FAO)
- Worldwide, over 36 million people are employed directly through fishing and aquaculture.

Aquaculture in California

- California's aquaculture industry is among the most diverse in the United States. Operations vary from small, family-run operations to sophisticated research and production facilities.
- California's aquaculture facilities are all sited in nearshore coastal waters, on land or in freshwater. None are located in offshore waters.
- Catfish, striped bass, tilapia, algae, trout and white sturgeon are among the most common species produced in California. No marine finfish are produced commercially.
- California has over 1,000 miles of coastline and 200,000 square miles of ocean space where mariculture might be developed in future.

Aquaculture and the Environment

- To grow successfully, the aquaculture industry must use ecologically sound practices and manage resources sustainably.
- Properly managed aquaculture operations can bring significant economic and social benefits with little or no environmental impact. In fact some 'impacts', such as increased reef habitat, can be positive.
- The responsible development of aquaculture requires that regulatory agencies, universities, fishermen and scientists work in concert to ensure that all environmental, permitting, logistical, legal and sociopolitical aspects of the industry are addressed.

The Need for Increased Production

- The annual U.S. demand for seafood is projected to increase by 3.3 billion pounds (35-50 percent) by the year 2010.
- This demand for seafood can only be met by sustainable harvests from fisheries complimented by increased production from aquaculture.
- Most likely these supplies will be imported from overseas because the prospects for increased supply from our natural fisheries are few and the U.S. aquaculture industry is still relatively small.
- The Department of Commerce recognizes this and is seeking ways to expand U.S. aquaculture consistent with its parallel goals for sustainable development.
- The U.S. ranks third in the world as a consumer of seafood but it is only eleventh in a worldwide ranking of aquaculture producers.
- In 2002 U.S. imports of seafood grew to a record 4.4 billion pounds worth $10.1 billion. This caused a net trade deficit in seafood estimated at $7 billion

Reference http://www.st.nmfs.gov/st1/trade/trade2002.pdf

For more information and references to facts about aquaculture, please refer to our Web site at www.gracemaricultureproject.org.

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Aquaculture Issues

Marine aquaculture (mariculture), especially in the offshore environment, is new to the United States. As a result of its novelty, questions have justifiably been raised regarding its practices and potential impacts. Unfortunately, in the absence of direct experience, misleading parallels have often been drawn to other forms of aquaculture or culture practices in other countries.

Hubbs-SeaWorld Research Institute (HSWRI) is committed to the notion that ocean farming will have to fill the increasing void in seafood supplies for future generations. We also recognize that, like all other human interactions with the environment, mariculture may have impacts. Our research mission is to address questions related to offshore mariculture and to evaluate, quantify and report our findings to the public and to resource managers whose job it is to assess the risks and benefits of mariculture relative to other uses of the marine environment. Our research goal is to find sustainable ways to use our nation's natural resources to meet our growing need for seafood.

HSWRI will conduct research designed to directly address the concerns associated with commercial scale development of offshore mariculture operations. These concerns are summarized in the following "issues":

Issue 1: Feeding fish to fish to make more fish

Background: Most marine fish consumed in the U.S. are carnivorous by nature - that is they consume other marine animals (fish, squid, crustaceans, etc). To meet the nutritional needs of these animals in culture, formulated feeds usually include fishmeal as the primary protein source. Fishmeal is produced from small baitfish such as sardines, anchovies, herring and menhaden and also, in some cases from fisheries processing waste.

There is concern that with the expansion of mariculture, increasing amounts of baitfish will be caught for use in feeds. The net result, some people argue, is that we will not be producing more protein by farming but in fact, less, due to the need to harvest more wild fish for fishmeal.

Factoids:

- Global production of fishmeal has remained stable for the last 15 years, averaging 13.6 billion pounds annually, except in El Niño years, when production is lower. In the same period global aquaculture production has increased almost threefold.
- Fisheries scientists and managers generally accept that the world's fishmeal fisheries are some of the best managed and sustainable fisheries.
- The fish from which fishmeal is made are not palatable to people. They are small, bony and extremely fishy tasting. Attempts to process them for use as an ingredient in human diets have, so far, failed.
- Worldwide, the majority of fishmeal (~65 percent) is used in livestock feeds for the pig and poultry industries as well as for fertilizer.
- Compared to these other agricultural uses of fishmeal, its use in feeds for mariculture may be more efficient because fish are better than terrestrial livestock at converting their feed into body mass.
- Some researchers have also shown that the conversion of baitfish into fishmeal and then into farmed fish may be up to five times more efficient than if the same baitfish were left as forage for wild fish in natural fisheries. This is due to the flow of energy in natural food webs and to the higher survivability of juvenile cultured fish over their wild counterparts. (Hardy and Forster, 2001)
- Powerful economic forces drive the selection and use of ingredients in animal feeds. Fishmeal will only continue to be used as long as it provides nutritional value while remaining cost competitive with other dietary protein sources such as soybeans and rape seed.
- Researchers and feed companies who support the aquaculture industry have recognized the need to evaluate different protein sources for many years. Substantial progress has been made in substituting other ingredients for fishmeal and fish oil in aquaculture feeds; a trend that will continue.
- The challenge for mariculture, as it is for other branches of animal agriculture, is how to get the maximum nutritional benefit for humanity from the minimum investment of natural resources? The fact that the answer may be found in some forms of mariculture is an extraordinarily compelling argument for more research in this field.

Issue 2: Nutrients from fish farms and the marine environment

Background: Like other animals and humans, as fish metabolize food, they naturally produce wastes in the form of soluble nitrogenous compounds and feces. As they break down, these wastes become a source of nutrients for plants and other animals and are recycled through the marine food chain. However, an excess of these wastes can cause localized problems such as build up of sediment on the seabed, or eutrophication in the water column that may, in some cases, cause unwanted side effects. Mariculture operations must, therefore be located and managed in a way that provides for the adequate dispersal and natural assimilation of wastes. Usually this means locating them in areas with medium to strong tidal currents and water depth greater than 60 feet.

A criticism of such an approach is that 'dispersal' is really a euphemism

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for 'dilution' and 'dilution is not the solution to pollution'. But in the case of nutrients, be they on land or in the ocean, this concept may be too simplistic. Animal wastes on land, for example, are normally used as fertilizers. In fact, when used under appropriately controlled conditions, such use is a prerequisite of organic farming. Dilution or dispersal into the soil in this case is generally considered to be a good thing.

The challenge for mariculture is to find a way to accomplish similarly productive dispersal of its wastes. The factors involved are complex, site-specific and sensitive to scale. But there is the prospect, if all the interacting factors can be understood, that the wastes released could result in a beneficial, localized enhancement of marine flora and fauna, including enhanced natural fisheries. Such an increase in productivity is frequently observed near mariculture operations today but, until now, it has been inadequately studied and documented.

One of HSWRI's goals in the Grace Project is to conduct research to seek the understanding needed to be able to predict and even control localized increases in productivity near mariculture facilities. HSWRI sees an opportunity here to turn the possible problem of wastes from mariculture into a benefit and believes, therefore, that this should be a priority area for its mariculture research effort.

Factoids:

- The wastes released by fish in mariculture projects are the same as those released by wild fish, namely nitrogenous wastes in solution (ammonia and urea) and feces, which contain mostly, undigested complex carbohydrates and fragments of bone. In addition, there is often a small proportion of uneaten (wasted) feed that passes through the net meshes and into the water column. These wastes do not contain toxicants, unlike many industrial and even domestic wastes, and they are biodegradable.
- Once released, ammonia and urea are quickly oxidized by marine bacteria and become nitrate - a basic plant nutrient.
- Solid wastes are similarly biodegraded by bacteria or, in some cases, may directly be consumed by marine invertebrates. But this process of degradation is slower and, therefore, these solid wastes can also, sometimes, accumulate on the seabed.
- Uneaten or wasted feed should, in well-managed farms, be a very minor portion of the overall solid waste. Clearly, it is not in the best interests of the operation to waste expensive raw materials. Today, fish farmers use a variety of monitoring devices, such as underwater cameras and acoustic Doppler systems to insure minimum wastage while, at the same time, making sure that the fish are adequately fed.
- The primary concern in managing these wastes is that the soluble materials do not become over-concentrated in too small a volume of water, or that the feces do not accumulate to an unacceptable level as settled solids on the seabed under the mariculture facility. These are easily monitored.
- Adverse effects on the behavior and performance of the captive fish themselves are almost always the first indicators of over concentration of soluble wastes. Therefore the problem is, in effect, self-regulating. It is in a fish farmer's own best interest to manage operations so that such over-concentration of wastes does not occur. Examples of soluble wastes having caused problems in mariculture are extremely rare.
- Accumulation of solid waste under a mariculture facility can be monitored by regular sediment sampling. In many cases such accumulation leads to an increase in benthic productivity and increased aggregations of fish and marine invertebrates, changes that may be considered beneficial. Benthic monitoring will be conducted routinely as part of the Grace Mariculture Project research activity according to EPA guidelines and the Project's environmental sampling program.
- Above all else, the management and potentially beneficial assimilation of wastes from mariculture is a matter of scale of activity relative to the water mass that surrounds it. Relative to the mass of ocean water surrounding the Platform Grace, the proposed HSWRI mariculture activity will be, for all practical purposes, insignificant. However, it will also be a first step in understanding the capacity of California's offshore waters to support a new industry that has the potential to grow for decades to come, in the process providing jobs and new source of seafood for our citizens.

Issue 3: Antibiotics used in fish farms

Background: Antibiotics are used to treat disease in all forms of animal husbandry. The likelihood that the pathogens targeted by the antibiotics will develop resistance increases over time. Excessive use of antibiotics exacerbates this process and is to be discouraged

Factoids:

- Disease prevention is the best way to minimize the need for antibiotics. Good water quality (i.e. offshore) supported by sound management and husbandry practices, such as low stocking densities, use of high quality feed, etc. are common and effective disease prevention mechanisms.
- The use of vaccines is another way. Vaccines have been especially effective in the salmon farming industry. The manufacturing and application techniques learned with salmon are now available for use with other new mariculture species.

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- Very few antibiotics are approved for use in farming food fish and the use of any is strictly regulated by the Food and Drug Administration (FDA).
- Any use of antibiotics by HSWRI is approved in advance by a licensed veterinarian and subsequently reported to the FDA.

Issue 4: Escaped fish and interactions with wild

Background: It is thought that escaped farmed fish may impact wild populations genetically if they breed with them. They may also affect them, behaviorally through competition and, possibly, through disease transfer if the farmed fish are carriers of disease.

Factoids:

- HSWRI will only be farming endemic (i.e. California) species for the Grace Mariculture Project.
- No transgenic fish products are currently commercially available in the U.S. and California maintains strict regulations regarding the use of transgenic organisms in aquaculture. HSWRI will not use any genetically modified organisms in the Grace Mariculture Project.
- In collaboration with the California Department of Fish and Game, HSWRI has intentionally released cultured fish into the ocean for nearly 20 years. During this period, HSWRI has consulted experts world-wide to better understand the genetic and ecological risks associated with allowing cultured fish to interact with wild ones. This experience will be brought to the Grace Mariculture Project.
- HSWRI employs state-of-the art cage equipment and strict maintenance practices to avoid system failures. HSWRI has operated a net pen facility at Santa Catalina Island for the past 5 years without an incident of system failure or escapement.